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The Practice of Project-Based Learning to Outdoor Ecological Education on the Promotion of Students' Problem-Solving Capability

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Abstract

People evolve from the nature; being in the nature is the best learning; and, a real classroom is the nature outside the window. The atmosphere of outdoor ecological education is therefore gradually formed. Outdoor ecological education has become an international trend in past years. Outdoor ecological education means the learning outside a classroom, expecting learners' learning, through exploration, observation, operation, interaction, reflection, and connection with five-sense experience, being closer to the life experience and to cultivate talents being able to adapt to future life. Applying non-equivalent experimental design to the experimental research, total 236 college students of universities in Taiwan, as the experiment objects, are preceded the 15-week (3 hours per week for total 45 hours) outdoor ecological education integrated project-based learning 2x2 experimental teaching. The research results summarize the significant effects of outdoor ecological education on problem-solving capability, project-based learning on problem-solving capability, and the practice of project-based learning to outdoor ecological education curriculum on the promotion of learning effect. According to the results to proposed suggestions, it is expected that college students would present deeper cognition and learning on outdoor ecological education to really achieve the application, exploration, and creation capabilities from outdoor ecological education curriculum.

Keywords: project-based learning, outdoor ecology, outdoor education, problem-solving capability, curriculum, social interaction.

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Introduction

Learning in classrooms might be dull and lack of authentic inspiration. It is not enough to explore the world merely through teachers' lecturing in classes, film introduction, listening to briefing, or picture viewing; students need more actual experiences. People evolve from the nature; being in the nature is the best learning; and, a real classroom is the nature outside the window. The atmosphere of outdoor ecological education is therefore gradually formed. Outdoor ecological education has become an international trend in past years. Outdoor ecological education means the learning outside classrooms, expecting learners' learning, through exploration, observation, operation, interaction, reflection, and connection with five-sense experience, being closer to the life experience and to cultivate talents being able to adapt to future life. A lot of countries and organizations also consider that classrooms are no long the sole place for learning and the practice of outdoor ecological education could expand learning styles. Many domestic schools, adventure education centers, Scouting Society of China, cultural and educational foundations, camping associations, and youth growth development centers devote to the development of outdoor ecological education. Apparently, outdoor learning and experience are multiple and rich. Learners could receive more stimuli outdoors than in classrooms, cultivate the spirit of mutual cooperation with others, and enhance the interaction among people and with the society. Ideas of field trip, outdoor teaching, and outdoor ecological education are similar, referring to learners, under the assistance and guide of teachers and parents, walking out of campuses, well applying community, the nature, and other off-campus resources, and connecting curriculum goals to experience the planned, integrated, and designed educational activity.

The effect of learning effectiveness of outdoor ecological education on college students is not predictable. Images viewed in the childhood would be stored in the brain to affect the life attitude and give encouragement and courage to face challenge after growing up. Outdoor ecological education is a good opportunity for learning and leisure; in addition to induce students' learning passion, it allows learners transforming abstract knowledge into specific action to have unforgettable perception. Learners do not simply receive knowledge of cognition and skills in the learning process, but would stress more on affective effects resulted from the active participation, special experience, and interaction with peers. The learning effectiveness of outdoor ecological education stresses on learners' learning process and allows learners authentically perceiving the value. No matter how the curriculum goals of outdoor ecological education are set, the integration of cognition, affection, and skills are necessary and important. Different from static learning in classrooms, outdoor ecological education induces learners' curiosity and deep perception through multiple and direct sensory stimulation to enhance learning interests and learning effectiveness. Teachers should take various considerations into account when practicing outdoor ecological education in different situations. For this

reason, this study intends to discuss the practice of project-based learning to outdoor ecological education curriculum for the promotion of students' problem-solving capability. It is expected to have college students' present deeper cognition and learning on hometowns and outdoor ecological education to authentically achieve the application, exploration, and creation capabilities in outdoor ecological education curriculum.

Literature review

Hwang, Hsu, & Hsieh (2019) mentioned that outdoor ecological education could provide the best learning situation; from a corner on campus, urban and rural communities, cultural places, farms, fisheries and ranches to mountains, plains, the earth, forests, and rivers, they are places for learning; outdoor ecological education could enrich life experience as well as develop the potential of multiple intelligences. Voukelatou (2019) stated that outdoor ecological education contained teaching outdoors; generally speaking, learning could occur in any places and was correlated to environment or any cultures. Stahlberg & Tuominen (2019) regarded outdoor ecological education as the teaching activity being preceded outdoors for the best effect, regardless of grades and subjects. Becker *et al.* (2017) indicated that outdoor ecological education was not a single subject, but the integration of school subjects, knowledge, and skills. Outdoor ecological education was not preceding teaching activity of all school subjects outdoors, but teachers applying environmental resources to assist students in understanding the mutual relationship among subjects, environment, and people. Quennerstedt (2019) regarded outdoor ecological education as the learning activity being able to integrate subject knowledge into educational meanings; students, under the guide of teachers and parents, could walk out of classrooms to precede targeted, planned, systematic, and programmed learning activity on campus and in communities, society, field, and the nature. James & Williams (2017) mentioned that outdoor ecological education emphasized to provide students with opportunities for experience and perception; the closer the learning content to the life, the students' learning motivation could be promoted; and, with outdoor ecological education, teachers could provide students with opportunities for experience, observation, participation, and reflection from specific activities to achieve the effect and goal of experiential learning. Aggarwal & Wu (2019) contained the objectives of outdoor ecological education as: (1) assisting students in receiving nature related knowledge from natural environment, (2) leading students to acquire knowledge from natural environment for developing conservation concept and cultivating outdoor skills, (3) inducing students' interests in natural environment to establish knowledge, (4) teaching students to respect the nature, (5) establishing correct attitudes towards natural environment through outdoor ecological education, 6.enhancing students' natural conservation concept, (7) providing students with opportunities to experience

authentic outdoor life for learning-by-doing, (8) paying attention to emphasizing learning and practice, balancing five ways of life, and cultivating physical and mental health, (9) teaching students practically using knowledge, and 10.allowing students establishing correct self-concept in the outdoor observation process. Cronin & Lowes (2016) emphasized that allowing students' active exploration and discovering the principles in the change of affairs were the major conditions of learning. Students' learning required teachers designing the environment for students finding out knowledge structure in real learning situations and guiding students to dig out such structure. Yoon, Goh, & Yan (2019) regarded the essence of outdoor ecological education as to induce learners' curiosity, using "discovery" as the learning style to achieve deep discussion. Mackenzie, Son, & Eitel (2018) mentioned that outdoor ecological education provided college students with rich opportunities for exploration and discovery, allowed students utilizing personal senses for experiencing the rules and knowledge of affairs, learning problem discovery and problem solving, and learning from problems to achieve meaningful knowledge acquisition. Accordingly, the following hypothesis is proposed in this study.

H1: Outdoor ecological education shows significant effects on problem-solving capability.

Kim & Lee (2019) proposed that project-based learning should focus on authentic problems, which were real and meaningful; students had to apply strategies and build learning structure by themselves in the problem exploration process and further seek for answers, cooperate with peers, and apply technological tools to develop the work. It conformed to what Sweller, van Merriënboer, & Paas (2019) stated that project-based learning stressed on students' active thinking and problem proposing, rather than simply answering teachers' questions, and had students apply the learned skills and professional ability to induce the intrinsic motivation, precede investigation and research, and eventually solve problems. Apparently, project-based learning emphasized authentic experience and students' self-directed exploration. Arici *et al.* (2019) defined project-based learning as discussion oriented learning; different from traditional separated subjects and learning not connecting to life, PBL stressed on learning integration and used life-combined authentic problems as the learning drive to have learners form problems and make and execute plans for learning. Salado, Chowdhury, & Norton (2019) defined project-based learning as following: (1) Project-based learning as a curriculum: Project-based learning focused on project tasks and other teaching strategies were the auxiliary; (2) Emphasis on students' responsibility: Project-based learning stressed on learning self-management and doing the duty to learn with others; (3) Covering authentic task: Project-based learning, either preceded indoors or outdoors, focused on affairs related to environment outside classrooms, including authentic tasks and valuable result output; (4) As constructive learning: Project-based learning stressed on matching the spirit of constructivism and induced a

series of issues for students' deep exploration through cooperative learning: (5) Presenting opportunity for direct learning: Reports, exhibitions, or peer evaluation allowed students directly learning from experience; (6) Influence on living skills: Project-based learning emphasized living skills and skills in the process, e.g. self-management, group process, and problem-solving capability. McAdams & Rijsdijk (2017) regarded project-based learning as a guide inducing students' thinking through situations and problems in the authentic world to establish the learning goals; through interdisciplinary self-directed learning, students could acquire new knowledge and correct old contents to solve problems and advance knowledge. Dunkley (2016) mentioned that learners were the main character in project-based learning; allowing individual students or teams fully developing and preceding exploration activity and preceding deep discussion aiming at students' interested topics could have students acquire knowledge and enhance the problem-solving capability. Kuechler & Stedham (2018) defined project-based learning as the strategy guiding students, aiming at problems, to think of solutions; teachers had to make a method to induce students discovering real problems, focusing on the problem discussion, and self-designing study to answer the question, and then preceding successive data collection and analysis, peer discussion, collaborative verification, and idea correction to construct the knowledge, develop strategies for metacognition through teamwork, and propose problem-solving programs to acquire practical knowledge. The following hypothesis is therefore proposed in this study.

H2: Project-based learning reveals remarkable effects on problem-solving capability.

Chen & Hung (2018) stated that outdoor ecological education stressed on providing students with experience in authentic situations and developing the potential of multiple intelligences; project-based learning also emphasized the combination with life experience and focused on authentic problems. In this case, the place for outdoor ecological education became the authentic database for project-based learning, from which students could explore and discover knowledge. Weng *et al.* (2018) explained the meaning of outdoor ecological education as to activate knowledge, integrate learning, and truly explore; it conformed to the emphasis of project-based learning on cultivating students' problem-solving capability. In terms of curriculum, Bardid & Meester (2016) indicated that outdoor ecological education was not a single subject, but the combination of all school subjects, knowledge, and skills; project-based learning emphasized integration but not separating subjects that students should learn complete knowledge and concepts, rather than acquiring information in specific field. Outdoor ecological education was emphasized because students could not learn the abilities of interacting with others, self-thinking, and problem solving in subject-oriented classroom environment; college students should walk out of classrooms to perceive and explore with the eyes and hands. Salmi, Kaasinen, & Suomela (2016) proposed project-based

learning 6A principles of authenticity, academic strictness, applied learning, active exploration, adult relationship, and evaluation practice. Apparently, both stressed on the importance of active exploration and authentic learning situations. Lee (2018) proposed similarities of both in the design of teaching activity; teaching activity design for outdoor ecological education contained type construction, field verification, discussion, and induction, while the steps for project-based learning covered setting teaching goal, establishing prior knowledge, proposing project-based problems, preceding investigation, evaluation and announcement, as well as group discussion and reflection; both would set teaching goals before the course and provide students with required prior knowledge to get into the actual field for verification and investigation, and eventually precede evaluation and discussion. Pistersa, Vihinenb, & Figueiredoc (2019) indicated that the spirit of project-based learning was similar to outdoor ecological education; both emphasized students preceding exploration and experience in authentic situations and returning the initiative of learning to students to cultivate the problem discovery and problem-solving capabilities and further apply such capabilities to other fields. As a result, the following hypothesis is proposed in this study.

H3: The practice of project-based learning in outdoor ecological education curriculum could notably enhance learning effect.

Methodology

Operational definition

(1) *Outdoor ecological education*: Outdoor ecological education (the experimental group) and general traditional teaching (the control group) are used for the outdoor ecological education experimental research.
(2) *Project-based learning*: Project-based learning (the experimental group) and general traditional teaching (the control group) are applied to the project-based learning experimental research.
(3) *Problem-solving capability*: Students' class notes, collaborative researchers' observation records, interview data, teachers' reflection notes, activity related photos, films, and students' works are collected for data organization and analyses to understand students' problem-solving capability.

Research object and research design

To effectively achieve the research objective and test research hypotheses, non-equivalent experimental design is applied to the experimental research. Aiming at students of universities in Taiwan as the empirical objects, total 236 students are preceded the outdoor ecological education integrated project-based learning 2x2 experimental research. The experiment is grouped into project-based

learning (project-based learning, general traditional teaching) X outdoor ecological education (outdoor ecological education, general traditional teaching) for the 15-week (3 hours per week for total 48 hours) experimental teaching.

Analysis method

Analysis of variance is utilized for discussing the effects of outdoor ecological education and project-based learning on problem-solving capability and further understanding the effect of outdoor ecological education integrated project-based learning on problem-solving capability.

Results

Variance analysis of outdoor ecological education to problem-solving capability

Analysis of variance is used in this study for discussing the difference of outdoor ecological education in problem-solving capability. From *Table 1*, outdoor ecological education and general traditional teaching show remarkable differences in problem-solving capability; outdoor ecological education outperforms general traditional teaching on problem-solving capability that H1 is supported.

Table 1: Variance analysis of outdoor ecological education

variable		F	P	Scheffe post hoc
outdoor ecological education	learning effect	34.182	0.000**	outdoor ecological education>general traditional teaching

** stands for p<0.05, ** for p<0.01.*

Variance analysis of project-based learning to problem-solving capability

Applying analysis of variance to discuss the difference of project-based learning in problem-solving capability, *Table 2* shows that project-based learning and general traditional teaching reveal notable differences in problem-solving capability; project-based learning outperforms general traditional teaching on problem-solving capability that H2 is supported.

Table 2: Variance analysis of project-based learning

variable		F	P	Scheffe post hoc
project-based learning	learning effect	41.175	0.000**	project-based learning>general traditional teaching

** stands for p<0.05, ** for p<0.01.*

Effects of the practice of project-based learning to outdoor ecological education curriculum

According to analysis of variance, the difference of practicing project-based learning to outdoor ecological education curriculum in problem-solving capability is discussed in this study. Two-way analysis of variance is further used for discussing the interaction of outdoor ecological education and project-based learning to verify the promotion effect of project-based learning. From Table 3, the practice of project-based learning to outdoor ecological education curriculum appears the highest problem-solving capability that H3 is supported.

Table 3: Variance analysis of the practice of project-based learning to outdoor ecological education curriculum on problem-solving capability

variable	problem-solving capability		
	F	P	Scheffe post hoc
outdoor ecological education	34.182	0.000**	outdoor ecological education>general traditional teaching
project-based learning	41.175	0.000**	project-based learning>general traditional teaching
outdoor ecological education*project-based learning	26.477	0.000**	11>12>21>22

** stands for p<0.05, ** for p<0.01.*

Discussion

In the project-based learning integrated outdoor ecological education curriculum, the teachers would precede self-reflection and talk with collaborative researchers for reflection and discussion. The teachers therefore regard the positive effect on the curriculum mapping ability, teaching philosophy, and teacher-student relationship. In regard to curriculum mapping ability, the teachers better understand the spirit of project-based learning that a lot of student presentation and active thinking are included in the course design, the lecturing time is reduced, and provide deeper learning meanings of outdoor ecological education with the output or project-based work. What is more, in addition to correcting course design and teaching styles after seeing students' responses in actual classes, they could acquire objective suggestions from collaborative researchers to expand the horizon and correct inadequate part in the session for next session. Regarding teaching philosophy, they acquire teaching confidence from students' progress and learning outcomes to ensure that the infinite potential of college students is waiting for teachers' development through different curricula. Consequently, teachers providing students with more challenge and experience opportunities would be new attempts and learning for both students and teachers, in which college students are changing and so as teachers. Both teachers and students collaboratively learning, discussing, and developing would be the best encouragement to teachers' teaching.

Conclusion

The research results show that students' problem-solving capability is promoted step by step, students could propose problems aiming at outdoor ecology, precede data collection through newspapers and magazines, Internet information, and interview with seniors, and precede field study. In the data collection process, students could select, organize, and deduce data matching the team topic to complete the project-based work, as well as learn the knowledge of other teams' topics through sharing. Students could correct the content in manuals, aiming at questions and suggestions from teachers and peers, to present the project-based work with complete structure. In the learning process of practicing project-based learning to outdoor ecological education curriculum, students cultivate the problem-solving capability, could present the learned knowledge and development trace on the project-based work, and further share with peers, teachers, and even future visitors to the outdoor ecology. Students present more positive attitudes towards the problem-solving capability. In addition to concentrating on and engaging in the class, students invest in lots of efforts to the production of project-based work. Such passion and activeness did not appear in past classes. For college students, assignments, examinations, and even learning sheets are the disgusting source of pressure. However, the project-based work is the goal that they eager to complete

and expect to exhibit in front of others; in this case, college students' learning attitudes are active and the learning outcomes are useful. It is the real learning which teachers would be glad to see.

Recommendations

According to the research conclusions, the following suggestions are proposed in this study.

– Tutors of the studied classes and directors with relevant research experiences are invited to be the collaborative researchers for this study. In the discussion and cooperation, it is deeply perceived that someone being able to objectively observe teachers' teaching and students' learning, share the past experience, and provide suggestions in the teaching site is important and precious. Many teachers could easily ignore or not pay attention to details, which are reminded by collaborative researchers to perfect the curriculum planning. For this reason, teachers could combine the same field, or interdisciplinary teachers could establish cooperative communities for teaching and learning as well as benefiting teachers and students.
– Students' course learning comes from the past life experience that the practice of project-based learning to outdoor ecological education curriculum should connect with students' actual experiences. Students would then present higher interests on data collection and problem-solving, propose problems close to life, show positive learning attitudes, propose problems, and active explore to achieve authentic learning for the application to real life.
– Before practicing the outdoor ecological education activity, teachers should implement orientation; in addition to definitely informing learners about the activity objective and content, students are requested to abide by activity rules and courtesy. Having learners be prepared in advance could have the activity be preceded smoothly and develop the best learning effectiveness of the outdoor ecological education activity.
– Teachers should plan outdoor ecological education activity matching the subject curriculum and students' interests, connect learners' experience and observation connecting with textbook knowledge and real environment, and induce students' learning motivation and desire so that outdoor ecological education would not be the recreation activity and suitable teaching styles could be found to enhance the learning effectiveness of teaching goals.

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